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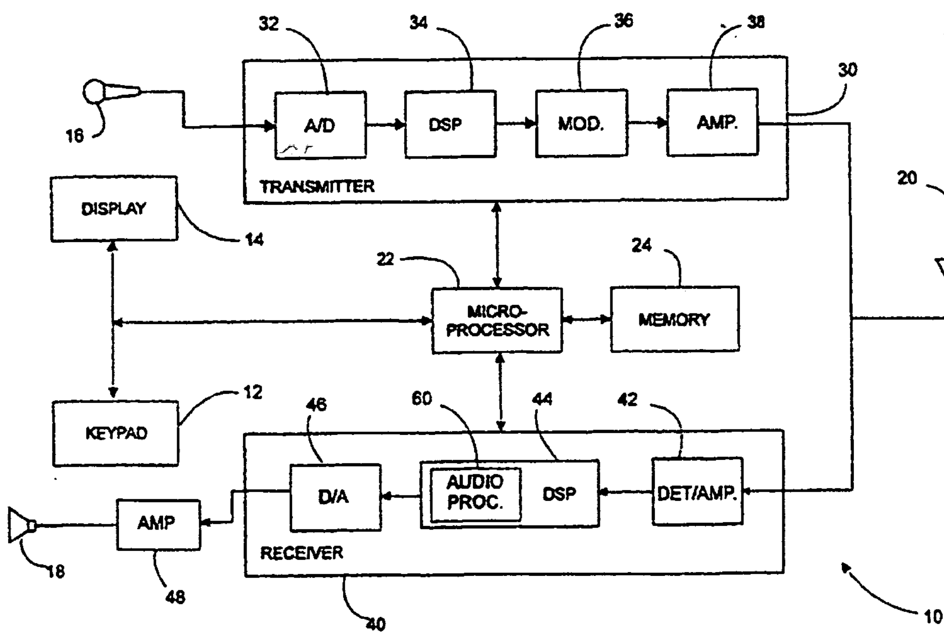

(57) Abstract

A radiotelephone having a variable frequency response that can be adapted to the hearing capabilities of the user. The radiotelephone comprises a transceiver operatively connected to a microphone and speaker. The transceiver includes an audio processing circuit having a variable frequency response for processing received audio signals for output through said speaker. The frequency response of the audio processing circuit is varied in response to user input of frequency response data. In one embodiment, predefined frequency response profiles are stored in memory and are applied based on user selection of a particular profile. In another embodiment, the user independently adjusts the gain applied to a plurality of predefined frequency bands to adjust the frequency response of the phone.

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SZ	Swaziland
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RADIOTELEPHONE WITH VARIABLE FREQUENCY RESPONSE

Field of the Invention

The present invention relates generally to mobile radio communication devices, such as cellular phones, and more particularly, to a mobile radio communication device having an adjustable frequency response for adapting the phone to a particular person's hearing.

Background of the Invention

Cellular phones are becoming increasingly popular in the United States and elsewhere. One reason for the popularity of cellular phones is that they liberate the user from being tied down to fixed communication networks. A user expecting to receive a call does not need to stay at home or the office while waiting for the call. The user can conduct business and travel from place to place and the call will be forwarded via the cellular communication network to whatever location the user happens to be in.

The hearing capability cellular telephone users may vary greatly from one user to another. Despite the differing hearing capabilities of users, cellular telephones have no way to adjust the speaker output to match a particular person's hearing capabilities except perhaps for volume control. The frequency response of the phone is determined by the manufacturer and is typically set for a person of average hearing capability. People with various types and degrees of hearing loss might have trouble using cellular telephones as a result of their hearing impairment. For example, people typically lose their high frequency hearing as they age. Persons with hearing loss in the high frequency portion of the speech spectrum may have a difficult time understanding speech because many sounds have much of their energy in the high frequency end of the speech spectrum. Different people, of course, may suffer hearing loss in different portions of the speech spectrum. Thus, it is virtually impossible to design a phone with a fixed frequency response that will be suitable for all users of cellular telephones.

Many users of cellular phones rely on hearing aids to compensate for their particular hearing loss. People with hearing aids will sometimes remove their hearing aids while using a portable telephone to prevent acoustic feedback in the hearing aid. People who find it necessary to remove their hearing aids in order to use a portable telephone may have difficulty understanding the conversation.

Accordingly, there is a need for a cellular telephone that can be adapted to the hearing capabilities of the end user.

Summary of the Invention

The present invention is a portable radiotelephone that can be adapted to the hearing capabilities of the end user. The phone includes a display for displaying information to the user and a keypad for receiving dialing instructions and commands from the user. A menu driven interface allows the user to select a desired frequency response from a list of pre-defined frequency response profiles. The pre-defined frequency response profiles may comprise, for example, a default profile, a bass boost profile, a mid-range boost profile, and a treble boost profile. The bass boost profile would amplify the lower frequencies in the speech spectrum, the mid-range profile would boost the mid-range frequencies in the spectrum, and the treble boost profile would amplify the higher frequencies in the speech spectrum. A person suffering from hearing loss in one of these three segments of the speech spectrum could compensate for his or her hearing loss by selecting the appropriate frequency response profile. The average user who is not hearing impaired would likely use a default profile based on the hearing capabilities of the average person.

In operation, received audio signals are input to a digital signal processor (DSP). The DSP modifies the audio signal by increasing the amplitude or gain of the audio signal according to the frequency response profile selected by the user. For example, if the user

selected the treble boost profile, the DSP would amplify the high frequency components of the audio signal.

In an alternative embodiment of the invention, the DSP could be programmed to allow the user to customize the frequency response of the phone to the user's individual hearing capability. In this embodiment, the user would be allowed to independently adjust the gain in two or more frequency bands in the speech spectrum. For example, the speech spectrum could be divided into three frequency bands referred to herein as the low frequency band, mid-range band and high frequency band. Using the keypad and display, the user would select the amount of gain to be applied in each of these three bands. For example, the user could select a desired gain factor on a normalized scale of 1 to 10 with 10 representing the greatest degree of gain allowed and 1 representing the minimum gain allowed. This implementation gives users greater control over the frequency response of the telephone. For example, using this embodiment it would be impossible to adjust the frequency response of the phone to match a hearing loss curve obtained from an audiologist.

Other objects and advantages of the present invention will become apparent and obvious from a study of the following description and the accompanyingdrawings which are merely illustrative of such invention.

Brief Desription of the Drawings

Figure 1 is a perspective view of a portable radiotelephone of the present invention.

Figure 2 is a block diagram of the portable radiotelephone.

Figure 3 is a block diagram of the audio processing circuit used in the radiotelephone to vary the frequency response of the phone.

Figure 4 is block diagram showing a menu tree used by the radiotelephone.

Figure 5A – 5C are illustrations of the user interface elements showing how the frequency response of the phone is set by the user.

Figure 6 is a block diagram of an alternate embodiment of the audio processing circuit used in the radiotelephone to vary the frequency response of the phone.

Figure 7 is a block diagram showing a menu tree used in the second embodiment.

Figures 8A – 8C are illustrations of the user interface elements showing how the frequency response of the phone is set in the second embodiment.

Detailed Description of the Invention

Figure 1 illustrates a hand-held radiotelephone 10 constructed in accordance with the present invention. The radiotelephone 10 is a fully functional radio transceiver capable of transmitting and receiving digital signals. The radiotelephone 10 includes a keypad 12, a display 14, a microphone 16, speaker 18, and antenna 20. The keypad 12 allows the operator to dial numbers, enter commands, and select options. The display 14 allows the operator to see dialed digits, call status information, and prompts. The microphone 16 converts the user's speech or other audible input into analog audio signals that are transmitted as hereinafter described. Speaker 18 converts received audio signals to an audible output that can be heard by the user.

Figure 2 is a block diagram of the radiotelephone 10. The radiotelephone 10 includes a microprocessor 22, program memory 24, a transmitter 30, and a receiver 40. The analog audio signals from the microphone 16 are applied to the transmitter 30. The transmitter 30 includes an analog to digital converter 32, a digital signal processor 34, a phase modulator 36 and RF amplifier 38. The analog to digital converter 32 converts the analog audio signals from the microphone 16 into a digital audio signal. The digital audio signal is passed to the digital signal processor 34 which compresses the digital audio signal and inserts error detection, error correction and signaling information. The compressed and

encoded signal from the digital signal processor 34 is passed to the modulator 36. The modulator 36 converts the signal to a form that is suitable for transmission on a RF carrier. The RF amplifier 38 boosts the output of the modulator 36 for transmission via the antenna 20.

The receiver 40 includes a detector/amplifier 42, digital signal processor 44, and a digital to analog converter 46. Digital signals received by the antenna 20 are passed to the receiver/amplifier 42 which boosts the low-level RF digital signal to a level appropriate for input to the digital signal processor 44. The digital signal processor 44 includes an equalizer to compensate for phase and amplitude distortions in the channel corrupted signal, and a demodulator for extracting the transmitted bit sequence from the received signal. A channel decoder detects and corrects channel errors in the received signal. The channel decoder also separates control and signaling data from speech data. The control and signaling data is passed to the microprocessor 22. Speech data is further processed by an audio processor 60, which is described more fully below, and passed to the digital to analog converter 46. One function of the audio processor 60 is to modify the audio signal according to a frequency response profile selected by the user to allow the frequency response of the radiotelephone 10 to be adapted to the user's hearing capabilities. The output of the DSP 44 is passed to the digital to analog converter 46. Digital to analog converter 46 converts the digital audio signal into an analog output signal. The analog output signal is amplified by amplifier 48 and passed to the speaker 18 to generate an audible output that can be heard by the user.

The microprocessor 22 coordinates the operation of the transmitter 30 and the receiver 40 according to program instructions stored in memory 24. These functions include power control, channel selection, timing, as well as a host of other functions. The microprocessor 22 inserts signaling messages into the transmitted signals and extracts signaling messages from the received signals. The microprocessor 22 responds to any

base station commands contained in the signaling messages, and implements those commands. When the user enters commands via the keypad 12, the commands are transferred to the microprocessor 22 for action.

Figures 3 shows in block diagram form one embodiment of the audio processor 60. The audio processor 60, as previously described, is a component of the DSP 44. The audio processor 60 modifies the audio signals received by the radiotelephone 10 to adjust the phone's output to the hearing capabilities of the user. The user selects a desired frequency response profile using the keypad 12 or other input device. Other types of input devices include, without limitation, pointing devices, touch screens, and speech recognition systems and other known devices for inputting commands into a computer or electronic device. The audio processor 60 applies the selected frequency response profile to the audio signals that are then passed to the D/A converter 46 and amplifier 48.

The audio processor 60 shown in Figure 3 comprises a variable response digital filter 62 and lookup table 64 which can be implemented in software or hardware. The digital filter 62 can be represented mathematically by an equation such as:

$$H_{(z)} = \frac{b_0 + b_1 z^{-1} + b_2 z^{-2} + \ldots}{1 + a_1 z^{-1} + a_2 z^{-2} + \ldots}$$

The *a*'s and *b*'s in the equation are called the filter coefficients. The structure of the filter 62 can be permanently programmed, yet simply changing the value of the filter coefficients can change the operational characteristics of the filter 62. The value of the filter coefficients for certain predefined frequency response profiles such as "bass boost," "midrange boost," "treble boost" and "normal" are stored in the lookup table 64. The user selects one of the predefined profiles via keypad 12 as will be described below. When the user selects a predefined profile, the microprocessor 22 sets a pointer 66 to the corresponding entry in the lookup table 64. The coefficients for the selected frequency response profile are then loaded into digital filter 62 for use in processing audio signals.

The user selects the desired frequency response profile using the keypad 12 and display 14 to access an option menu stored in memory 24. A representative example of a menu tree which is suitable for practicing the present invention is shown in Figure 4. The various program modes available to the user reside at the top level of the menu tree, referred to herein as the mode level. In the present invention, one of the available programming modes is the "ADJUST FREQUENCY RESPONSE MODE." Other programming modes are also available. Each programming mode has a series of corresponding options. For example, the ADJUST FREQUENCY RESPONSE MODE includes four options - BASS BOOST, MIDRANGE BOOST, TREBLE BOOST, and DEFAULT. Using the keypad 12 and display 14, the user navigates through the option menu and selects the desired options.

Figures 5a through 5c illustrate the manner in which the user selects a desired frequency response profile. First, the user enters the programming mode by pressing the ENTER key on the keypad 12. Once the user enters programming mode, a prompt is displayed on display 14. Each prompt at the mode level of the menu tree includes a text message corresponding to that particular programming mode. For example, the prompt shown in Figure 5a reads "ADJUST FREQ. RESPONSE." Beneath the text message is a list of choices which are available. In Figure 5a, the available choices are LEFT ARROW, RIGHT ARROW, YES, and NO. The left arrow key and right arrow key on keypad 12 are used to scroll through the available modes or options on the same level of the menu tree. Pressing YES moves the user down one level in the menu tree. Pressing NO moves the user up one level.

Figure 5b shows a prompt at the option level of the menu tree. This example assumes that the user has selected the ADJUST FREQUENCY RESPONSE mode. Again, the prompt includes a text message which describes a corresponding option and a list of choices. Again, the choices include LEFT ARROW, RIGHT ARROW, YES and NO.

Pressing the LEFT ARROW or RIGHT ARROW key on the keypad 12 scrolls through the available options for the selected programming mode. To accept an option, the user presses YES. To move back up to the mode level, the user presses NO.

When the user presses YES at the lowest level of the menu tree, the prompt shown in Figure 5c is displayed. The prompt includes a text message that reads, "SAVE CHANGES." In this case, only two choices, YES or NO are presented to the user. To save the changes, the user presses YES on the keypad 12. Once the changes are saved, the microprocessor 22 exits the programming mode and sets the pointer 66 to the selected frequency response profile. To reject the changes, the user presses NO. The microprocessor 22 returns the user to the option level of the menu tree.

The embodiment described above limits the user's choices to certain pre-defined frequency response profiles. This approach will suit the needs of most cellular telephone users. However, in some cases, more control over the frequency response characteristics of the phone may be desired.

Figure 6 illustrates an alternate embodiment of the audio processor 60 that provides a greater degree of flexibility in matching the frequency response of the radiotelephone 10 to the user's hearing capabilities. In the embodiment shown in Figure 6, the user can independently adjust the gain in specific segments of the speech spectrum using the keypad 12 and display 14. This alternate embodiment of the audio processor 60 comprises three predefined filters 68, 70, 72, three multipliers 74, 76, 78, and a summer 80. The filters 68, 70, 72 are defined and programmed for predetermined frequency bands. The embodiment shown divides the audio signal into three bands referred to as the bass band or low frequency band, the mid-range band, and the treble band or high frequency band. The audio signal is split at point 67. The low frequency portion is passed by filter 68, the mid-range frequency portion is passed by filter 70, and the high frequency portion is passed by

filter 72. Those skilled in the art will recognize that the number of bands and filters used is not a material aspect of the invention.

The output of the filters 68, 70, 72 are multiplied by corresponding multipliers 74, 76, 78 to independently vary the gain in each frequency band. The multipliers 74, 76, 78 multiply the output of the corresponding filters 68, 70, 72 by gain factors input by the user as will be described more fully below. The gain factors give the user independent control over each frequency band within predefined limits (i.e. minimum and maximum gain values). The outputs from multipliers 74, 76, 78 are applied to the summer 80 which combines the signals for output to the D/A converter 46.

One advantage of the embodiment shown in Figure 6 is that the user can customize the frequency response to his or her particular hearing capabilities. That is, the user can adjust the gain for each individual frequency band independently from the other bands.

Figure 7 shows a menu tree for the second embodiment. As in the previous embodiment, the top level, or mode level, contains the various programming modes which are available to the user. One of those modes is the ADJUST FREQUENCY RESPONSE mode. Each programming mode includes a series of program options which can be selected by the user. For example, the ADJUST FREQUENCY RESPONSE mode includes three options – ADJUST BASS, ADJUST MIDRANGE, and ADJUST TREBLE. The user selects the desired frequency band from the option group associated with the selected programming mode. For example, to increase the amount of bass in the speaker output of the radiotelephone 10, the user would select the ADJUST BASS option. After selecting the desired frequency band to adjust, the user then inputs a gain factor. The gain factor can be input in a variety of ways. One method would be for the user to input a numerical value corresponding to the desired gain factor. For example, the user could input a gain factor of 1 to 20 on a normalized scale with 1 representing the lowest gain factor and twenty representing the highest gain factor. Alternately, the right arrow and left arrow keys could be

used to increment or decrement the gain factor in a manner similar to a volume control or slider. The latter approach is probably more intuitive to the user.

Figures 8a through 8c illustrate the steps performed by the end user to adjust the frequency response in the second embodiment. Figure 8a shows a prompt that is displayed to the user after the user presses the ENTER key on the keypad 12. The prompt includes a text message or descriptor and a list of choices which the user can make. Again, pressing the LEFT ARROW key or RIGHT ARROW key allows the user to scroll through the various programming modes available to the user. When the desired mode is reached, the user presses the YES key to move one level down in the menu tree. At each level of the menu tree, the user uses the RIGHT ARROW or LEFT ARROW key to scroll through the available choices and presses YES when the desired choice is reached.

To adjust the frequency response of the phone, the user navigates through the menu tree, selects the ADJUST FREQUENCY RESPONSE mode, and then selects one of the frequency bands. After selecting the frequency band to adjust, an adjustment control, such as the one shown in Figure 8c, is displayed on display 14. The adjustment control includes a meter which provides a visual indication of the current gain factor for the selected frequency band. The user presses the RIGHT ARROW and LEFT ARROW keys to either increment or decrement the gain for the selected band and then presses YES to accept the changes. Again, the user may be prompted to save the changes before exiting the programming mode.

The present invention may, of course, be carried out in other specific ways than those herein set forth without departing from the spirit and essential characteristics of the invention. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive, and all changes coming within the meaning and equivalency range of the appended claims are intended to be embraced therein.

What is claimed is:

1. A radio communication device comprising:
   a) a speaker;
   b) a transceiver operatively connected to said speaker for receiving audio signals;
   c) an audio processing circuit having a variable frequency response operatively connected to said transceiver and said speaker for processing received audio signals for output through said speaker; and
   d) a user interface for inputting frequency response data by a user of said radio communication device;
   e) wherein said audio processing circuit is responsive to said frequency response data input by the user to vary the frequency response of said audio processing circuit.

2. The radio communication device according to claim 1 further including a memory for storing a plurality of predefined frequency response profiles selectable by the user, wherein the audio processing circuit is responsive to user input to apply the selected frequency response profile.

3. The radio communication device according to claim 2 wherein said audio processing circuit comprises a filter circuit having variable filter coefficients, wherein said filter coefficients are changed to vary the frequency response profile of the audio processing circuit.

4. The radio communication device according to claim 3 wherein values for said filter coefficients are stored as part of said frequency response profiles and are applied based on the user's selection of a frequency response profile.

5. The radio communication device according to claim 1 wherein said audio processing circuit comprises a plurality of filter circuits for filtering selected frequency bands in said audio signal.

6. The radio communication device according to claim 5 further including means to independently vary the gain of said filter circuits to vary the frequency response of said radio communication device.

7. The radio communication device according to claim 1 wherein said user interface comprises a keypad and display.

8. The radio communication device according to claim 7 including a memory for storing prompts output to said display, wherein said user inputs frequency response data by pressing keys on said display in response to said prompts.

9. A radio communication device comprising:
   a) a speaker;
   b) a transceiver operatively connected to said said speaker for transmitting and receiving audio signals;
   c) an audio processing circuit having a variable frequency response operatively connected to said transceiver and said speaker for processing received audio signals for output through said speaker, said audio processing circuit including means for varying the frequency response of said audio processing circuit in response to user input.

10. The radio communication device according to claim 8 further including a memory for storing a plurality of predefined frequency response profiles that can be selected by the

user, wherein the audio processing circuit is responsive to user input to apply the selected frequency response profile.

11. The radio communication device according to claim 10 wherein said audio processing circuit comprises a filter circuit having variable filter coefficients.

12. The radio communication device according to claim 11 wherein said audio processing circuit comprises a filter circuit having variable filter coefficients, wherein said filter coefficients are changed to vary the frequency response profile of the audio processing circuit.

13. The radio communication device according to claim 10 wherein said audio processing circuit comprises a plurality of filter circuits for filtering selected frequency bands in said audio signal.

14. The radio communication device according to claim 13 further including means to independently vary the gain of said filter circuits in response to user input.

15. The radio communication device according to claim 10 further including input means for inputting frequency response data by a user.

16. The radio communication device according to claim 15 wherein said input means comprises a keypad and a display.

17. The radio communication device according to claim 16 including a memory for storing prompts output to said display, wherein said user inputs frequency response data by pressing keys on said keypad in response to said prompts.

18. A radio communication device comprising:.
    a) a speaker;
    b) a transceiver operatively connected to said speaker for transmitting and receiving audio signals;
    c) an audio processing circuit having a variable frequency response operatively connected to said transceiver and said speaker for processing received audio signals for output through said speaker;
    d) a memory for storing predefined frequency response profiles;
    e) means for selecting a desired frequency response profile by a user; and
    f) control means responsive to said user selection to vary the frequency response of said audio processing circuit.

19. A radio communication device comprising:
    a) a speaker;
    b) a transceiver operatively connected to said microphone and said speaker for transmitting and receiving audio signals;
    c) an audio processing circuit having a variable frequency response operatively connected to said transceiver and said speaker for processing received audio signals for output through said speaker, said audio processing circuit including a plurality of discrete filters for selected frequency bands;
    d) means for independently varying the gain of said filters.

20. A method for varying the frequency response of a radio communication device having a transceiver for receiving audio signals and a speaker comprising:
    a) inputting a received audio signal into an audio processing circuit having a variable frequency response;

b) setting the frequency response of said audio processing circuit by a user;

c) filtering said audio signal in said audio processing circuit based on the frequency response set by said user;

d) outputting said filtered audio signal to said speaker.

21. The method according to claim 20 wherein the step of setting said frequency response includes selecting a predefined frequency profile from a stored list of frequency response profiles.

22. The method according to claim 21 wherein the step of filtering said audio signal includes setting coefficients of a filter in said audio processing circuit to values associated with said selected frequency response profile.

23. The method according to claim 20 wherein the step of setting the frequency response includes inputting two or more gain factors corresponding to predetermined frequency bands.

24. The method according to claim 23 wherein the step of filtering said audio signal includes amplifying each predetermined frequency band in said audio signal by the corresponding gain factor entered by said user.

25. A method for varying the frequency response of a radio communication device having a transceiver for receiving audio signals and a speaker comprising:

a) inputting a received audio signal into said audio processing circuit having a variable frequency response;

b) inputting by a user of a desired frequency response profile from a list of predefined frequency response profiles;

c) setting the frequency response of said audio processing circuit so that the frequency response of the audio processing circuit corresponds to the frequency response profile selected by the user;

d) filtering said audio signal;

e) outputting said filtered audio signal to said speaker.

26. A method for varying the frequency response of a radio communication device having a transceiver for receiving audio signals and a speaker comprising:

a) providing an audio processing circuit having a variable frequency response;

b) inputting a received audio signal into said audio processing circuit having a variable frequency response;

c) selecting by a user of gain factors for predetermined frequency bands;

d) setting the gain of said audio processing circuit for said predetermined frequency bands in accordance with the user's selection;

e) filtering said audio signal in said audio processing circuit;

f) outputting said filtered audio signal to said speaker.

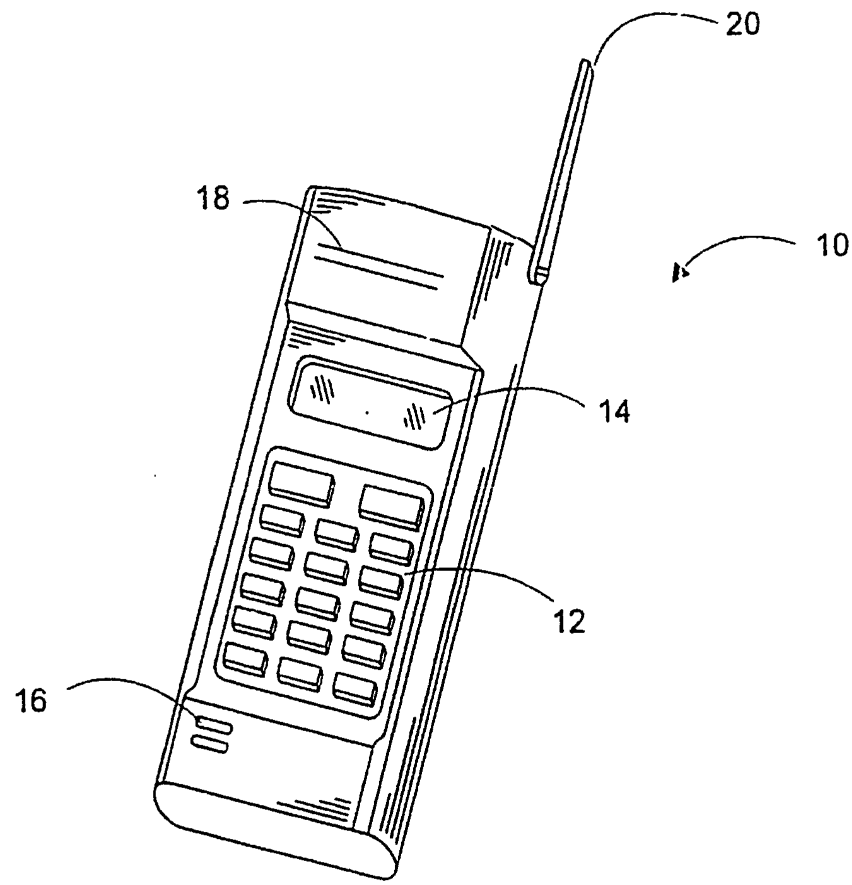
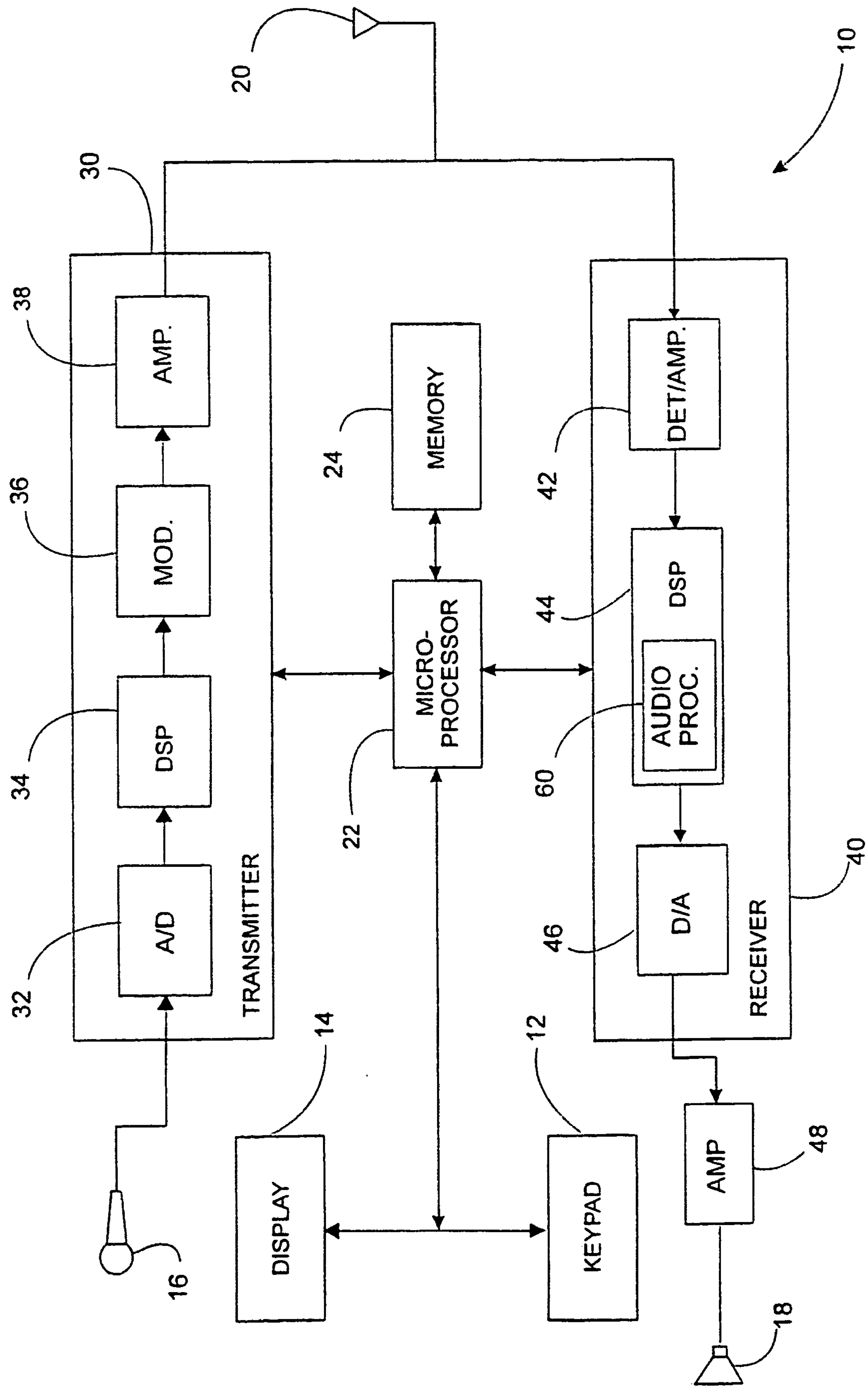


FIG. 1


TRANSMITTER
A/D
DSP
MOD.
AMP.
MEMORY
MICRO-
PROCESSOR
DET/AMP.
DSP
AUDIO
PROC.
D/A
RECEIVER
DISPLAY
KEYPAD
AMP
10
12
14
16
18
20
22
24
30
32
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40
42
44
46
48
60

FIG. 2

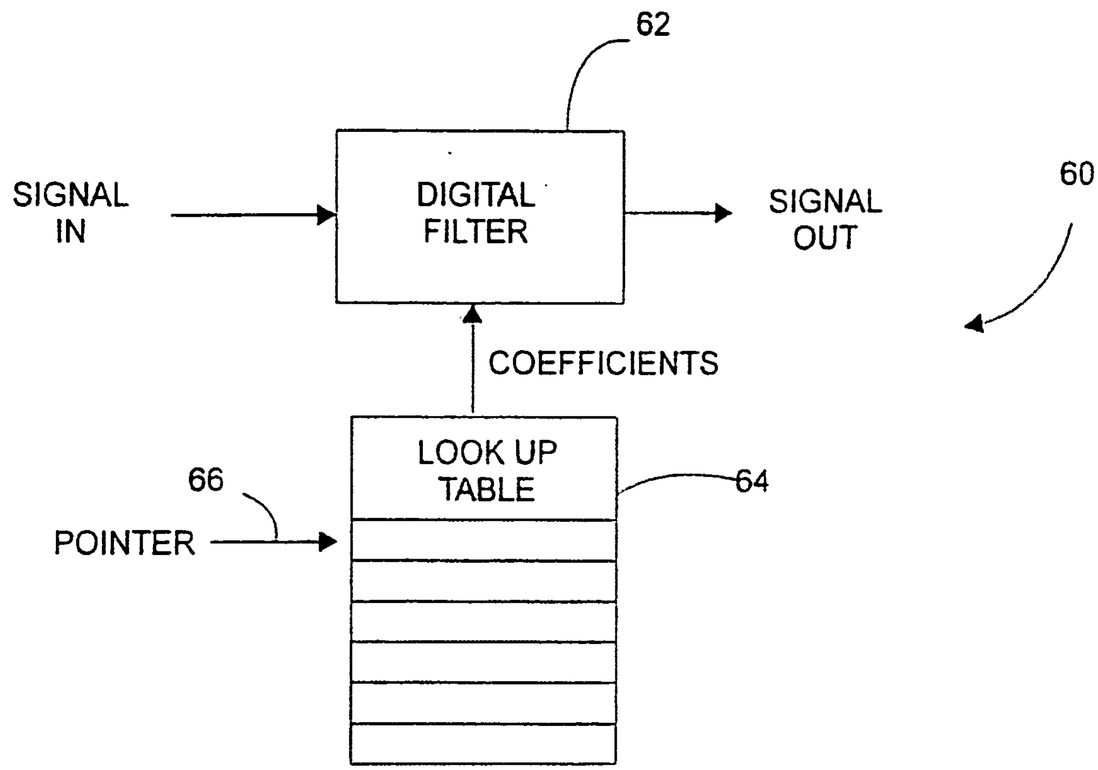
62
SIGNAL IN
DIGITAL FILTER
SIGNAL OUT
60
COEFFICIENTS
LOOK UP TABLE
66
POINTER
64

FIG. 3

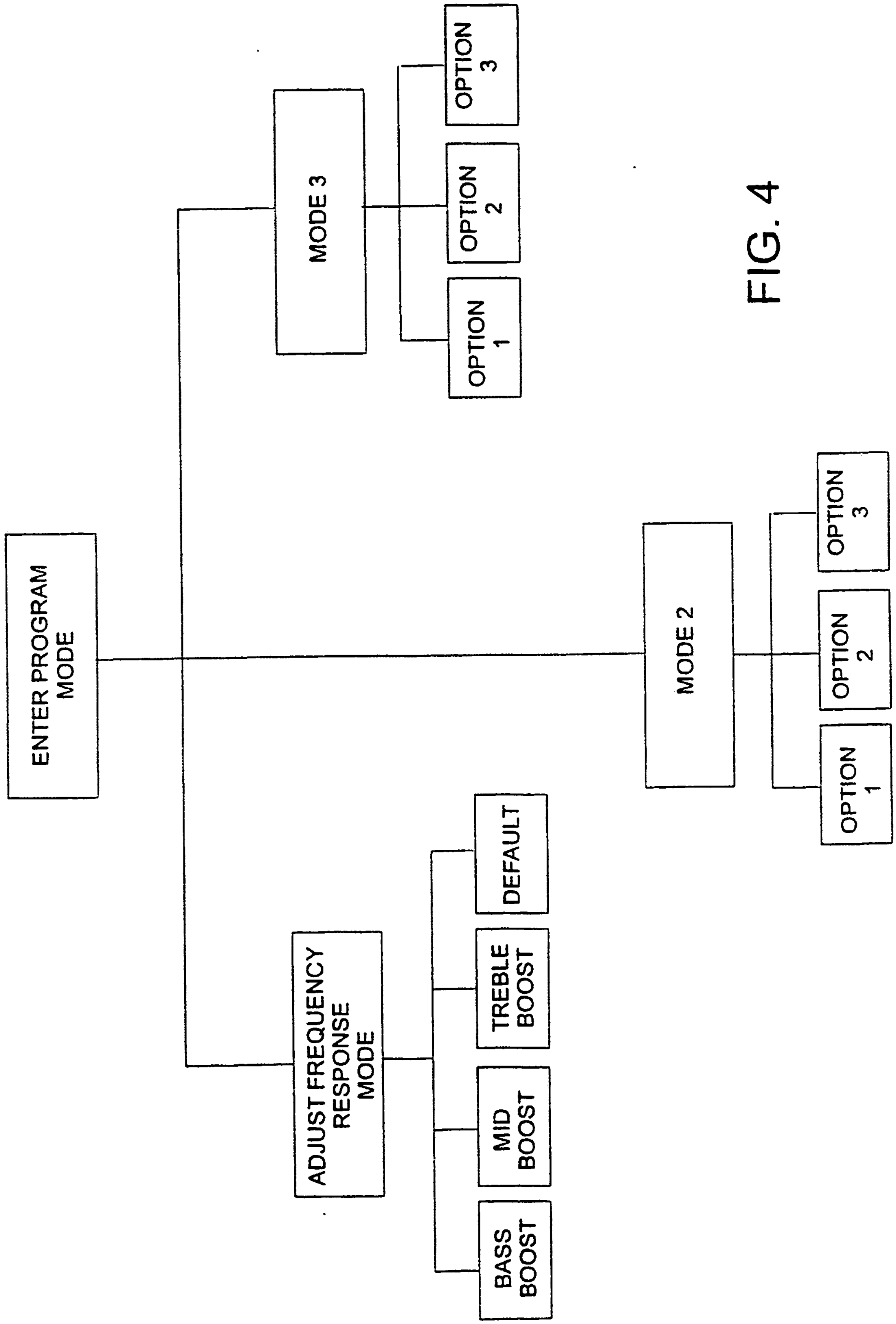
ENTER PROGRAM MODE
ADJUST FREQUENCY RESPONSE MODE
BASS BOOST
MID BOOST
TREBLE BOOST
DEFAULT
MODE 2
OPTION 1
OPTION 2
OPTION 3
MODE 3
OPTION 1
OPTION 2
OPTION 3

FIG. 4

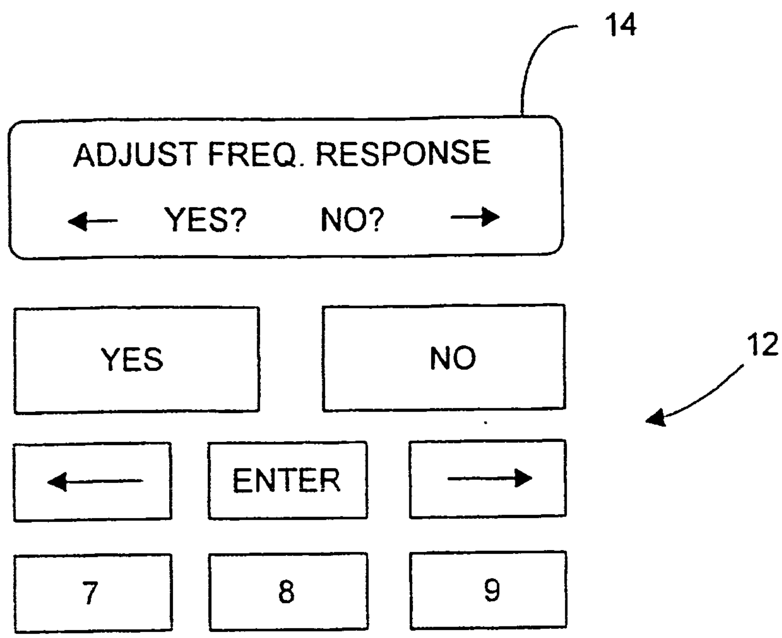
14
ADJUST FREQ. RESPONSE
YES? NO?
YES
NO
12
ENTER
7
8
9

FIG. 5A

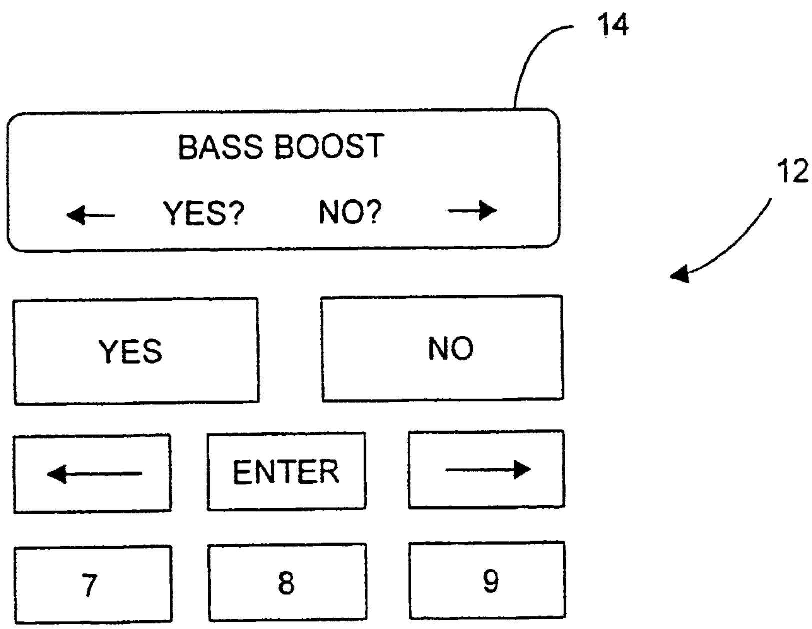
14
BASS BOOST
YES? NO?
12
YES
NO
ENTER
7
8
9

FIG 5B

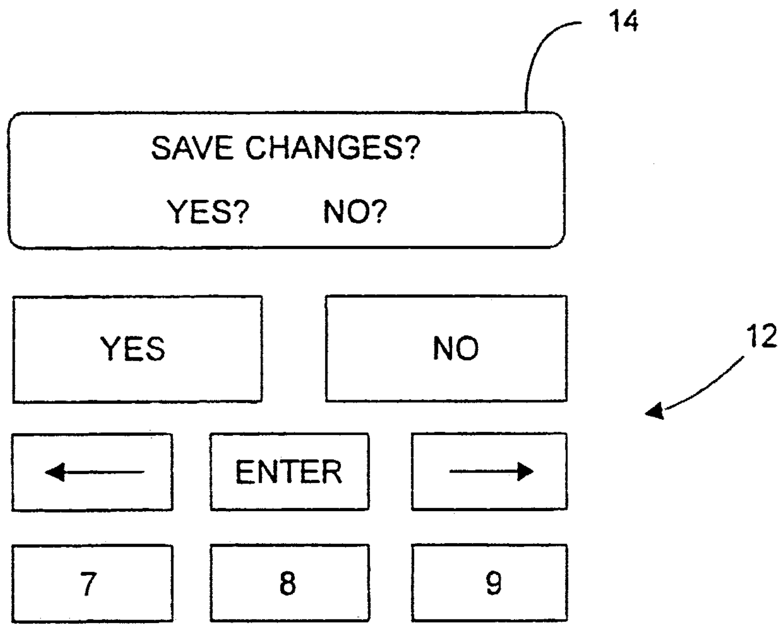

FIG. 5C

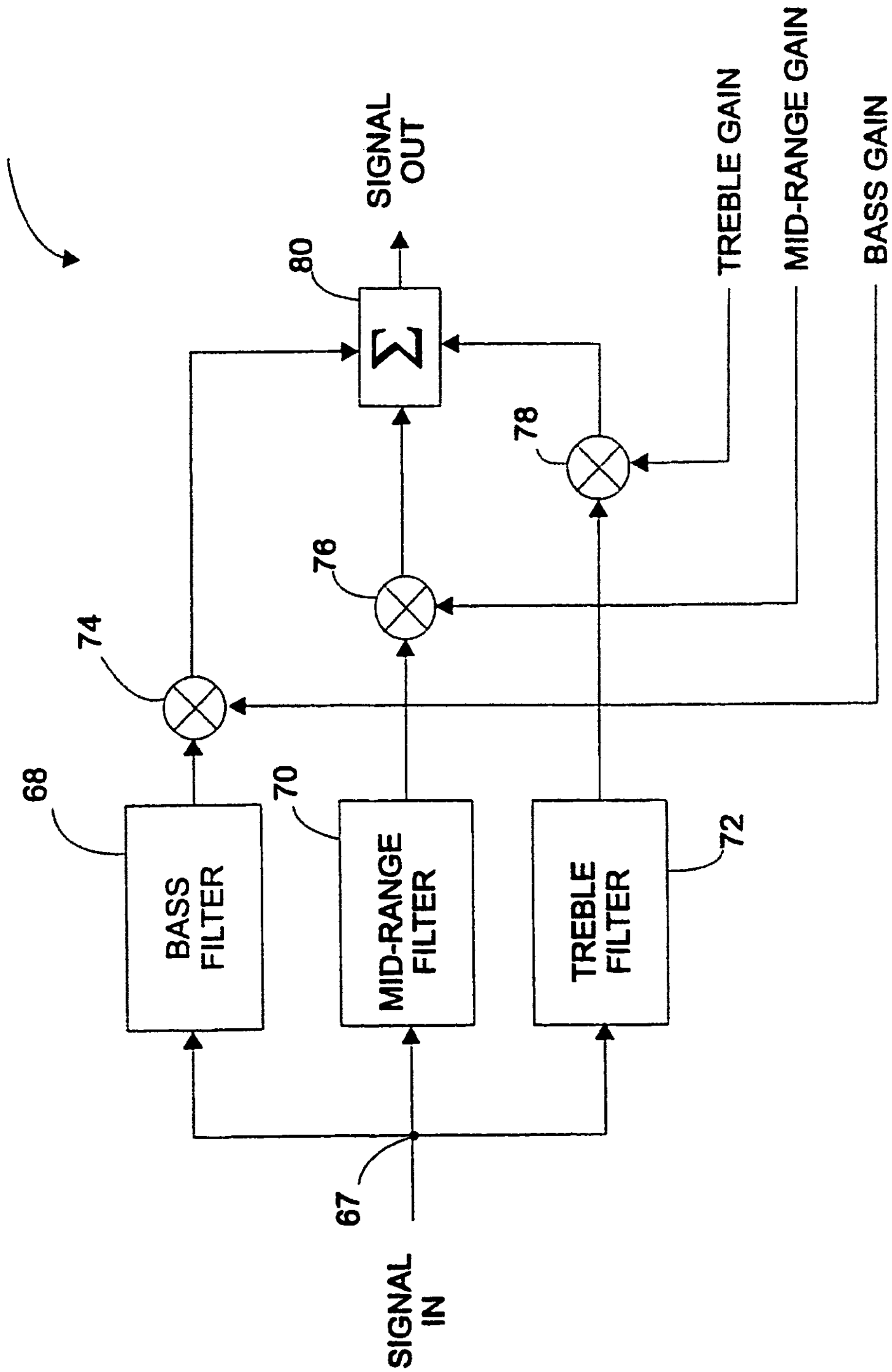
SIGNAL IN
67
BASS FILTER
68
MID-RANGE FILTER
70
TREBLE FILTER
72
74
76
78
80
Σ
SIGNAL OUT
TREBLE GAIN
MID-RANGE GAIN
BASS GAIN

FIG. 6

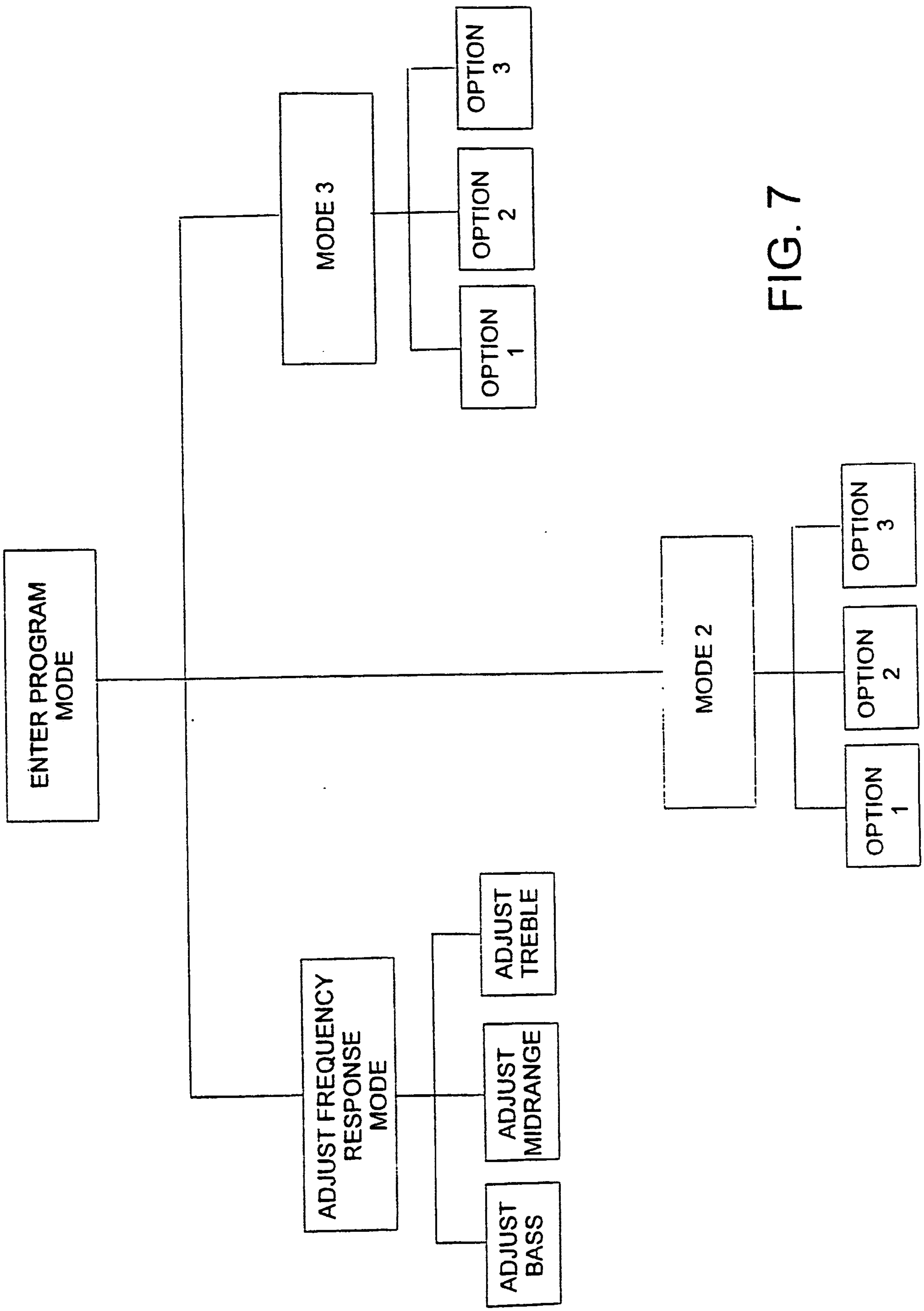
ENTER PROGRAM MODE
ADJUST FREQUENCY RESPONSE MODE
ADJUST BASS
ADJUST MIDRANGE
ADJUST TREBLE
MODE 2
OPTION 1
OPTION 2
OPTION 3
MODE 3
OPTION 1
OPTION 2
OPTION 3

FIG. 7

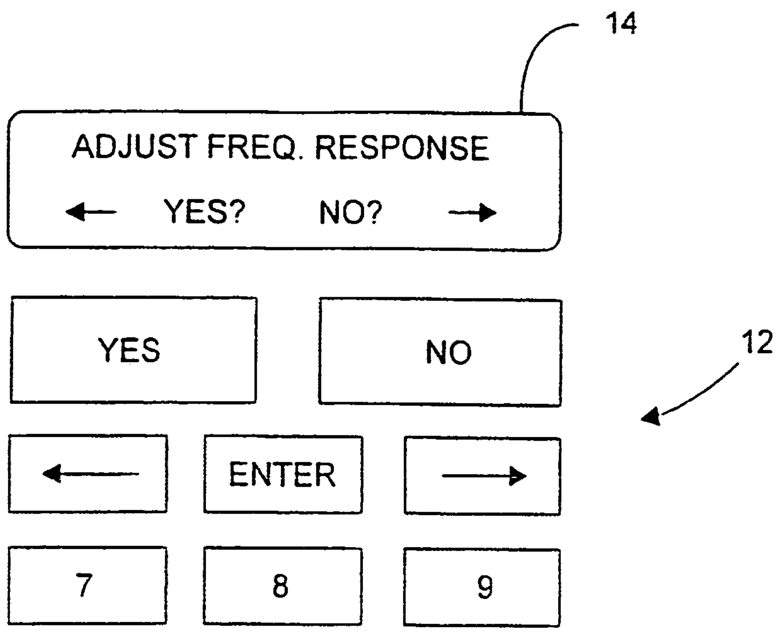
14
ADJUST FREQ. RESPONSE
YES? NO?
YES
NO
12
ENTER
7
8
9

FIG. 8A

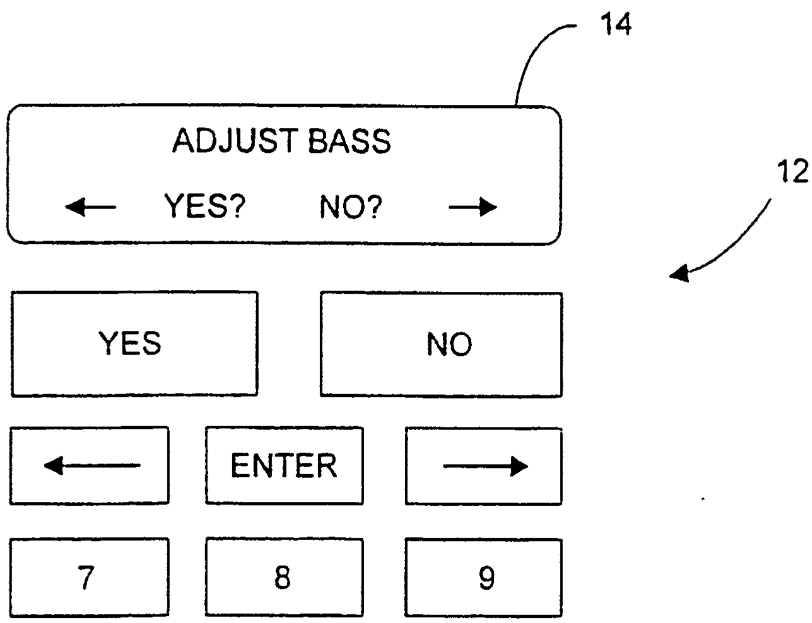
14
ADJUST BASS
YES? NO?
12
YES
NO
ENTER
7
8
9

FIG 8B

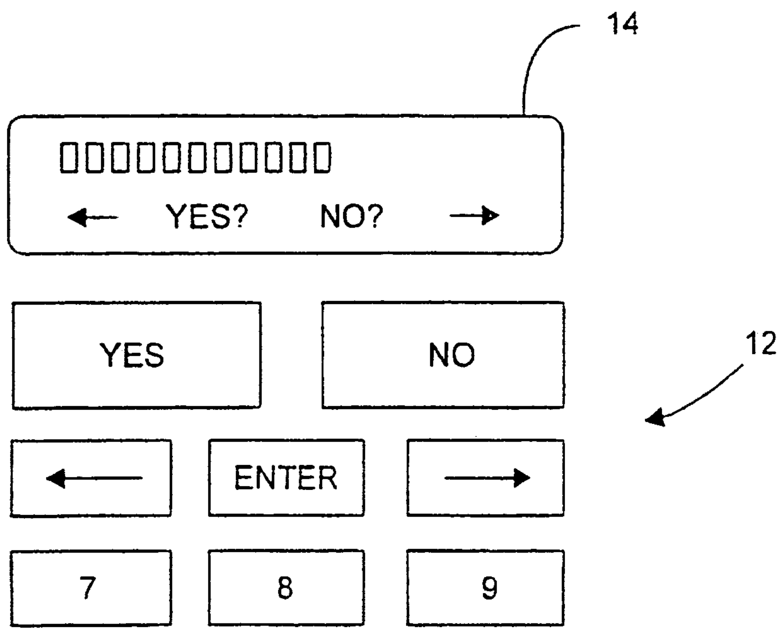

FIG. 8C

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(74) Agent: COATS & BENNETT, PLLC; P.O. Box 5, Raleigh, NC 27602 (US).

(81) Designated States *(national)*: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZA, ZW.

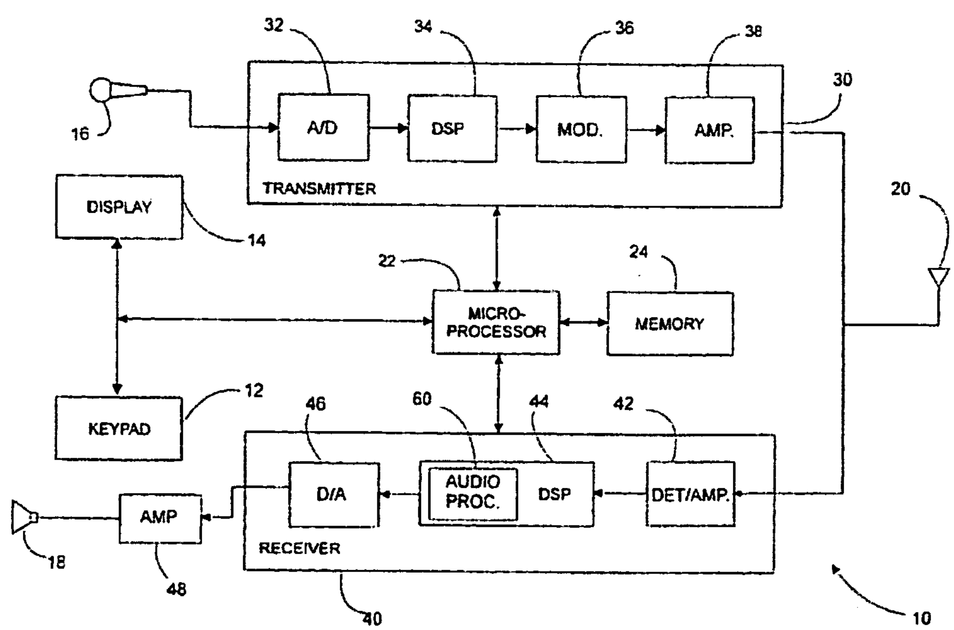
(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

(88) Date of publication of the international search report: 19 September 2002

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: RADIOTELEPHONE WITH VARIABLE FREQUENCY RESPONSE



(57) Abstract: A radiotelephone having a variable frequency response that can be adapted to the hearing capabilities of the user. The radiotelephone comprises a transceiver operatively connected to a microphone and speaker. The transceiver includes an audio processing circuit having a variable frequency response for processing received audio signals for output through said speaker. The frequency response of the audio processing circuit is varied in response to user input of frequency response data. In one embodiment, predefined frequency response profiles are stored in memory and are applied based on user selection of a particular profile. In another embodiment, the user independently adjusts the gain applied to a plurality of predefined frequency bands to adjust the frequency response of the phone.

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/16982

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04M1/60 H04M1/725

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 98 05150 A (QUALCOMM INC) 5 February 1998 (1998-02-05) abstract page 4, line 1 -page 7, line 39 figures 1-5 ---	1-26
X	PATENT ABSTRACTS OF JAPAN vol. 013, no. 366 (E-806), 15 August 1989 (1989-08-15) & JP 01 123554 A (TOSHIBA CORP;OTHERS: 01), 16 May 1989 (1989-05-16) abstract --- -/--	1,9, 18-20, 25,26

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
4 November 1999	11/11/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Golzio, D

INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 1995, no. 04, 31 May 1995 (1995-05-31) & JP 07 023098 A (CASIO COMPUT CO LTD), 24 January 1995 (1995-01-24) abstract	1,9, 18-20, 25,26
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